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The predictive value of obstructive sleep apnoea severity on clinical outcomes following maxillomandibular advancement surgery

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Abstract

We aimed to evaluate whether the severity of preoperative obstructive sleep apnoea (OSA) has potential predictive value for the clinician assessing patients referred for maxillomandibular advancment surgery. We performed a retrospective analysis of consecutive patients who underwent maxillofacial operations for OSA at our institution. We stratified them into 2 groups according to apnoea/hypopnoea index (AHI) scores calculated from a preoperative sleep study: mild-moderate OSA (AHI less than 30) and severe OSA (AHI 30 and above). Both groups were matched for baseline demographic and clinical characteristics. We compared postoperative scores for the AHI and Epworth sleepiness scale (ESS), and lowest recorded oxygen saturation between groups. We identified 51 patients of whom 39 had complete data available for inclusion in our analysis. We found no statistically significant difference in the postoperative AHI scores between the two groups. The reduction in the mean ESS after operation was greater in the severe group than in the mild-moderate group (mean (SD) ESS 4 (3) compared with 9 (6), $p < 0.05$). There were high rates of surgical success (postoperative AHI less than 15) in both groups, and results were comparable (mild-moderate group 82%, severe group 86%). The preoperative AHI does not appear to be a good predictor of surgical success after maxillomandibular advancement surgery. Patients with severe OSA postoperatively demonstrated a greater improvement in their subjective symptoms, when compared to subjects with mild-moderate OSA.

Keywords: Maxillomandibular advancement; Maxillofacial surgery; Obstructive sleep apnoea; AHI; Severity; Outcome; Predictor; Outcomes

Introduction

Obstructive sleep apnoea (OSA) is characterised by obstructions or near obstructions of the upper airway during sleep. It has a reported prevalence of 5% in the adult population and is a known cause of many adverse health-related problems. Its association with sudden cardiac death, stroke, metabolic diseases, depression, and road traffic accidents has been well described.[1–3]

OSA is characterised by periodic reductions (hypopnoea) or cessations (apnoea) in breathing secondary to obstruction of the upper airway, and is subdivided into varying degrees of severity depending on the apnoea/hypopnoea index (AHI), an objective measure calculated from a sleep study (mild-moderate: AHI 5–30/hour, severe: AHI more than 30/hour).

Continuous positive airway pressure (CPAP) remains the first-line treatment worldwide, but some patients can be successfully managed by making changes in their lifestyle with or without the use of mandibular advancement devices.

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Unfortunately, long-term adherence remains a serious problem and studies have reported non-compliance of around 40%.[4,5] A European Respiratory Society working group, which identified a need to develop alternative treatments to help manage the increasing burden of morbidity, concluded that maxillomandibular advancement was as effective as CPAP and should be suggested for patients who cannot tolerate long-term, non-invasive interventions.[6]

Currently there is no widely agreed classification that can help sleep specialists to select the patients best suited for surgical treatment. There is also limited evidence-based guidance on predicted outcomes after operations on the facial skeleton for OSA.[7]

Patients with a severe condition have the highest risk of developing adverse sequelae.[1,3] There is a poor correlation between the severity of OSA (based on the AHI) and the associated subjective symptoms of daytime sleepiness and poor quality of life.[8,9] Excessive daytime somnolence is formally evaluated using the Epworth sleepiness scale (ESS), a validated questionnaire in which patients are asked to rate the likelihood of dozing in 8 different situations with a maximum score of 24 (normal range 0–10).

The objective of this study was to evaluate whether the preoperative severity of OSA has potential predictive value for maxillofacial orthognathic operations in patients who have been unable to tolerate non-invasive treatments. The association between severity and surgical outcome has previously been considered in patients undergoing uvulopalatopharyngoplasty for OSA, and some studies have reported better success rate in those with mild disease.[10] Currently there is a paucity of research on the predictive role of severity of disease in the context of outcomes after maxillomandibular advancement for OSA.

Method

We retrospectively reviewed outcomes in a consecutive group of patients who underwent an orthognathic surgical procedure for OSA at our institution between 2002 and 2012.

They had all been diagnosed after clinical investigation and diagnostic sleep study, and had subsequently failed to comply with, or adhere to, use of CPAP and other non-invasive treatments.

We obtained pertinent data from the medical records including characteristics, medical history, and clinical and operative details, as well as data from sleep studies. All patients had the necessary sleep studies before, and no less than 6 months postoperatively.

Patients were divided into 2 groups based on the severity of the condition: mild-moderate (AHI less than 30) and severe (AHI 30 and above).

The predictor variable in the study was the severity of OSA at initial presentation and the primary outcome variable was the postoperative AHI score. The secondary outcome variables were ESS scores and lowest recorded oxygen saturation after surgery.

For the purposes of the study, we considered surgical success to be a postoperative AHI score of less than 15, and 50% reduction in the AHI from baseline. Surgical cure was defined as an AHI of less than 5 on the postoperative sleep study.

Data analyses were performed using SPSS for Windows version 17.0 (SPSS Inc, Chicago). Bivariate analysis was done to measure association between postoperative sleep study data and severity of OSA. The independent sample *t* test was used to evaluate differences in continuous variables and the chi square test to compare categorical variables. For all tests P values <0.05 was considered statistically significant.

Results

We identified 51 patients who had maxillomandibular advancement for OSA during the study period. Preoperative and postoperative data on sleep studies were available for inclusion in 39. There were 11 (28%) in the mild-moderate group (AHI less than 30) and 28 (72%) in the severe group (AHI 30 and over).

The baseline characteristics of both groups stratified by AHI scores are shown in Table 1. There was no significant difference in any baseline characteristic, apart from a previous history of uvulopalatopharyngoplasty and or nasal surgery. A total of 9 of the 11 patients in the mild-moderate group and 8 of the 28 in the severe group had previously undergone upper airway surgery ($p = 0.003$).

Clinical data and information relating to the extent of maxillomandibular advancement are shown in Table 2. Table 3 shows the results of the analysis of the outcome variables (AHI, ESS, and lowest recorded oxygen saturation) in the 2 groups. Fig. 1 shows a comparison of the postoperative AHI scores between groups.

All our patients except one reported an improvement in subjective symptoms following surgery. There was a statistically significant difference between groups in the postoperative ESS scores with a lower mean score in the severe group ($p = 0.04$). Improvements in oxygenation after operation were comparable in both groups, and in both the mean nocturnal oxygen saturation exceeded 90%.

A total of 9/11 (82%) patients in the mild-moderate group had an AHI of less than 15, which is suggestive of surgical success, compared with 24/28 (86%) in the severe group ($p = 0.76$). Similarly, the difference in the rate of surgical cure (AHI less than 5) when stratified by mild-moderate and severe OSA was not significant (45% compared with 57%, respectively, $p = 0.51$).

Discussion

Our data showed no significant difference in the primary outcome variable between groups, and rates of surgical success were high and comparable. Our findings suggest that, irrespective of the severity of OSA preoperatively, patients derived benefit from maxillofacial intervention. The data

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Table 1
Baseline characteristics of the study sample. Data are number (%) unless otherwise stated.

	Mild-moderate group (AHI <30)($n = 11$)	Severe group (AHI ≥30)($n = 28$)	p value
Mean (SD) age (years)	45 (7)	44 (7)	0.87
Sex			0.25
Male	11	25	
Female	0	3	
Mean (SD) BMI	28 (4)	29 (3)	0.67
Smokers	4	8	0.63
Alcohol	8	22	0.69
ASA ≤2	9	24	0.55
Mallampati ≤2	9	19	0.38
Coexisting conditions	2	8	0.84
Previous operation	9	8	0.03
Mean (SD) ESS	13 (5)	14 (4)	0.63
Mean (SD) minimum oxygen saturation (%)	75 (9)	76 (11)	0.91

BMI = Body mass index; ASA = American Society of Anesthesiologists' physical status classification; ESS = Epworth sleepiness scale; Mallampati = Mallampati airway classification score.

Table 2
Orthognathic data of the study sample. Data are number or mean (SD).

	Mild to moderate group (AHI <30) ($n = 11$)	Severe group (AHI ≥30) ($n = 28$)	p value
Malocclusion			0.49
Class I	5	21	
Class II	5	7	
Edentulous	1	0	
Procedure			0.64
Bimaxillary advancement with genioplasty	10	23	
Bilateral sagittal split osteotomy	0	2	
Bimaxillary operation	1	3	
Mean (SD) maxillary advancement (mm)	8.1 (1)	8.6 (2)	0.37
Mean (SD) mandibular advancement (mm)	8.2 (1)	8.5 (2)	0.68

Table 3
Comparison of preoperative and postoperative outcome measures when stratified by baseline apnoea/hypopnoea index (AHI) scores. Data are mean (SD).

Postoperative scores	Mild to moderate group (AHI <30)	Severe group (AHI ≥30)	p value
Apnoea/hypopnoea index	10 (6)	8 (3)	0.42
Epworth sleepiness scale	9 (6)	4 (3)	0.04
Lowest recorded oxygen saturation (%)	79 (6)	83 (7)	0.91

however, do not support the hypothesis that the preoperative severity of disease is a predictor of surgical outcome.

Freidman et al. explored this area in patients undergoing uvulopalatopharyngoplasty for OSA.[11] They compared patients with mild OSA ($n = 45$) with those with severe OSA ($n = 49$) as defined by the baseline AHI. The authors reported surgical success of around 26% in both groups, and concluded that the severity of disease had no predictive role in the preoperative assessment of these patients.

Holty and Guilleminault systematically reviewed the effectiveness of maxillomandibular advancement for OSA.[12] They pooled data on individual patients from 27 reports that described different populations ($n = 320$), and also considered predictors of surgical success. Interestingly, characteristics predictive of success on univariate analysis included the female sex and a low preoperative AHI score, but they were not predictive of success on multivariate analysis. The pooling of sleep study data has limitations given the heterogeneity in the criteria used for the scoring of apnoeas and hypopnoeas (AHI). Currently, the wide variety of apparatus used in diagnostic sleep studies varies in sophistication, calibration, and sensitivity, and constitutes a potential confounding factor in the pooling of data. Another consideration is the most appropriate timing of the postoperative assessment of surgical outcome after maxillomandibular advancement. We chose a minimum interval of 6 months before the study was repeated, but other authors who reported comparable success rates used a 3-month interval.[13] The long-term durability of improvements in the AHI after maxillomandibular advancement has been well documented and indicates sustained benefit.[14–16]

The secondary outcome variables in our study were a reduction in postoperative ESS and minimum oxygen saturation. The difference between groups in minimum oxygen

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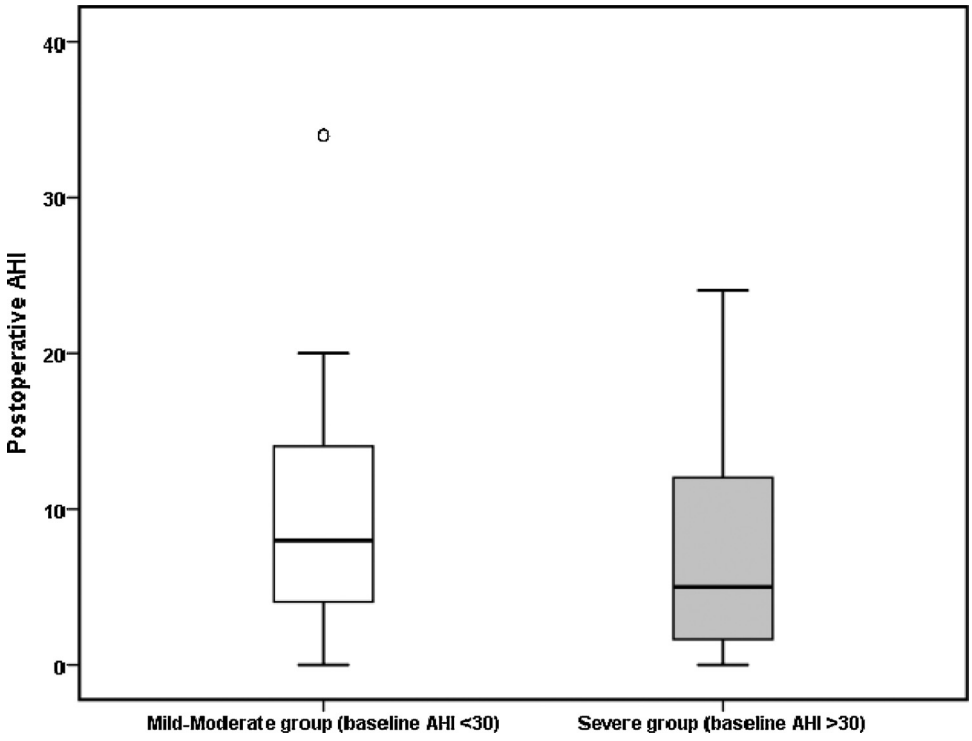

Fig. 1. Box plot showing apnoea/hypopnoea index (AHI) scores in moderate and severe OSA groups after maxillomandibular advancement.

saturation after operation was not significant. The preoperative value in the mild-moderate and severe groups was 75% and 76%, respectively, and postoperatively was 79% and 83%, respectively. The overall mean nocturnal oxygen saturation exceeded 90% in all patients after operation. The numerical difference in minimum values could be considered modest, but after maxillomandibular advancement, the oxygen saturation nadir values were above 78% in both groups. Recent studies have highlighted the importance of lowest nocturnal oxygenation values as an independent risk factor for sudden cardiac death, with an increased risk (HR 2.6) at below 78%.[17] In our study the mean values in both groups rose from below this threshold to above it following surgery.

All patients except one reported an overall improvement in their subjective symptoms. The reduction in the mean ESS after surgery was greater in the severe group than in the mild-moderate group ($p = 0.04$). Previous studies have reported poor correlation between changes in objective measures and subjective symptoms.[8,9] However, subjective symptoms are of paramount importance to patients consenting to undergo invasive surgery, and our data suggest that those with severe OSA would appear to derive greater relief from their OSA symptoms, particularly from excessive daytime somnolence.

Of the 39 patients, 72% had severe OSA and 28% mild-moderate OSA, but preoperative ESS scores were comparable in both groups. Interestingly, the mild-moderate group had a significantly higher rate of previous upper airway surgery for OSA (9/11 (82%) compared with 8/28 (29%) in the severe group). This finding could be explained in a number of ways. It is possible that a more traditional procedure such as uvulopalatopharyngoplasty with or without nasal surgery had been considered suitable, and that the ongoing symptoms may have been related to multilevel obstructions in the upper airway that had not been fully corrected by previous operations. The well-described Stanford protocol advocates a 2-phase operation in patients with OSA.[18] The initial phase comprises uvulopalatopharyngoplasty with or without an adjuvant procedure, and phase 2 involves maxillomandibular advancement. Recently, published studies have tended to support a primary multilevel approach.[19]

In our group, a different surgical team had operated on the upper nasal airway before these patients were referred to our unit for consideration for maxillomandibular advancement. The correction of nasal obstruction has been shown to improve symptoms of nocturnal breathing through the mouth but does not effectively alleviate OSA. Patients who have primary multilevel operations and who also have nasal obstruction could have this corrected at the same time by septoplasty or turbinectomy, or both, through a Le Fort I approach.

Another explanation for the higher number of previous operations in the mild-moderate group could be that previous single-level operations had reduced the severity of the disease. However, the AHI remained high, and ESS scores of 10 or more are indicative of ongoing symptoms.

Our results show that the preoperative AHI is not a good predictor of surgical success after maxillomandibular advancement for OSA. The surgical outcomes seem to be favourable in both groups.

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The results of our study would support sleep clinicians referring patients from the full severity spectrum who have failed non-invasive management of their OSA. Most of our patients had a marked improvement in their subjective symptoms, the greatest improvement being seen in those with severe OSA.

Conflicts of interest

We have no conflicts of interest.

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